Electronic Supplementary Information (ESI) for Journal of Materials Chemistry C

Benefits of surfactant effects on quantum efficiency enhancement and temperature sensing behavior of $NaBiF_4$ upconversion nanoparticles

Pengpeng Lei,[a,b] Ran An,[a] Xuesong Zhai,[d] Shuang Yao,[a] Lile Dong,[a,c] Xia Xu,[a,b] Kaimin Du,[a,c] Manli Zhang,[a,c] Jing Feng,[a,*] and Hongjie Zhang[a,*]

[a] State Key Laboratory of Rare Earth Resource Utilization, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, 5625 Renmin Street, Changchun 130022, China

[b] University of Chinese Academy of Sciences, Beijing 100049, China

[c] University of Science and Technology of China, Hefei 230026, China

[§]School of Materials Engineering, Yancheng Institute of Technology, Yancheng 224051, China

* Corresponding authors. Tel.:+86 431 85262127; fax: +86 431 85698041.
E-mail addresses: fengj@ciac.ac.cn (J. Feng), hongjie@ciac.ac.cn (H. Zhang).

KEYWORDS: $NaBiF_4$, upconversion luminescence, polyacrylic acid, quantum efficiency, temperature sensing

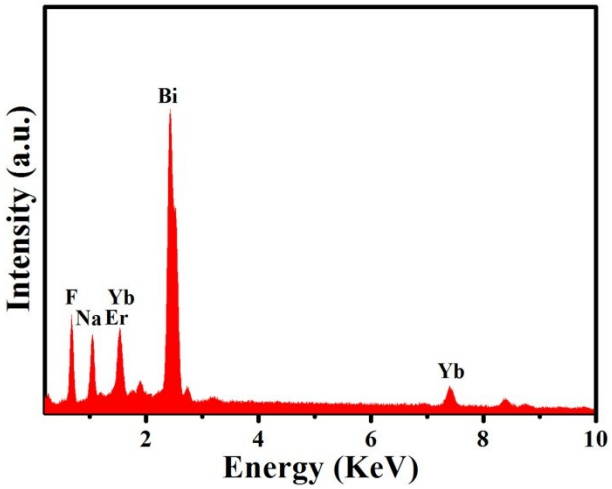

Fig. S1 X-ray Energy-dispersive (EDX) spectroscopy of $NaBiF_4:Yb^{3+}/Er^{3+}$ UCNPs.

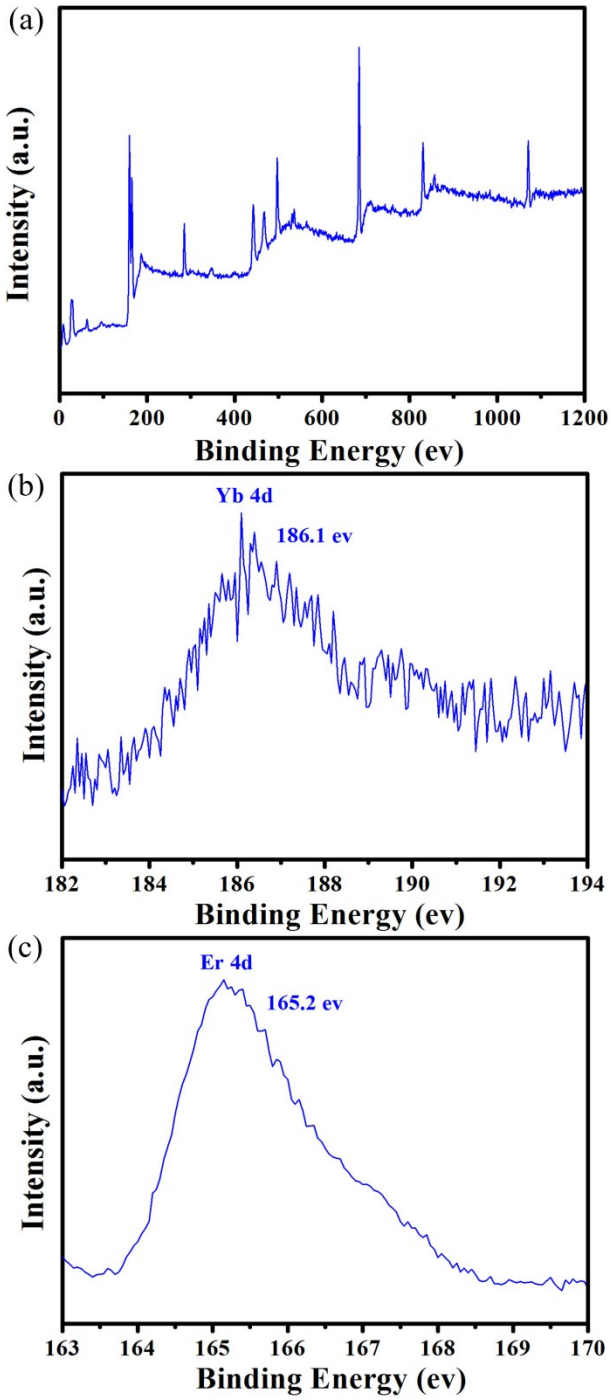

Fig. S2 X-ray photoelectron spectroscopy (XPS) survey spectra of $NaBiF_4$:Yb^{3+}/Er^{3+} UCNPs. (a) survey, (b) Yb 4d, and (c) Er 4d.

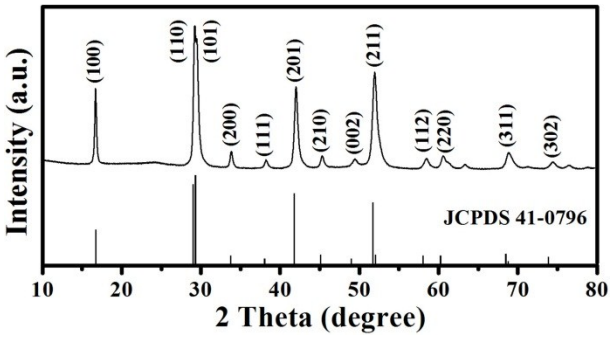

Fig. S3 XRD pattern of PAA-modified $NaBiF_4$:Yb^{3+}/Er^{3+} UCNPs.

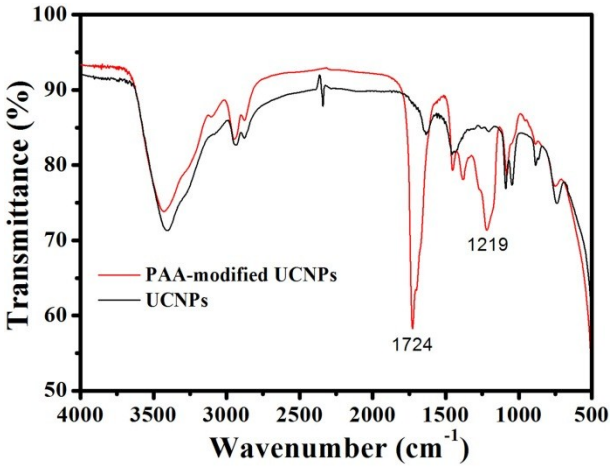

Fig. S4 FT-IR spectra of $NaBiF_4:Yb^{3+}/Er^{3+}$ and PAA-modified $NaBiF_4:Yb^{3+}/Er^{3+}$ UCNPs.

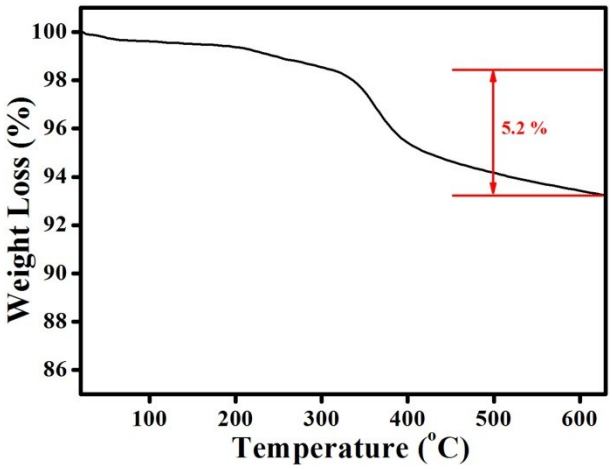

Fig. S5 Thermo-gravimetric (TG) analysis of PAA-modifeid $NaBiF_4$:Yb^{3+}/Er^{3+} UCNPs.

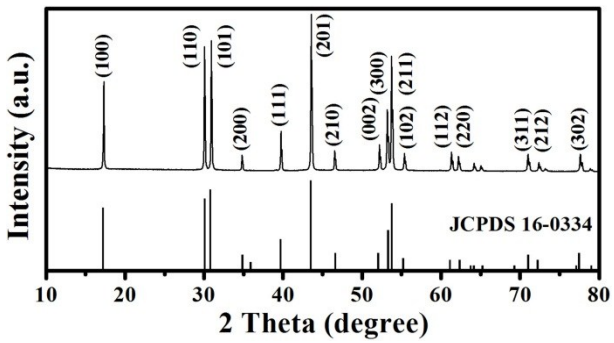

Fig. S6 XRD pattern of $NaYF_4$:Yb^{3+}/Er^{3+} UCNPs.

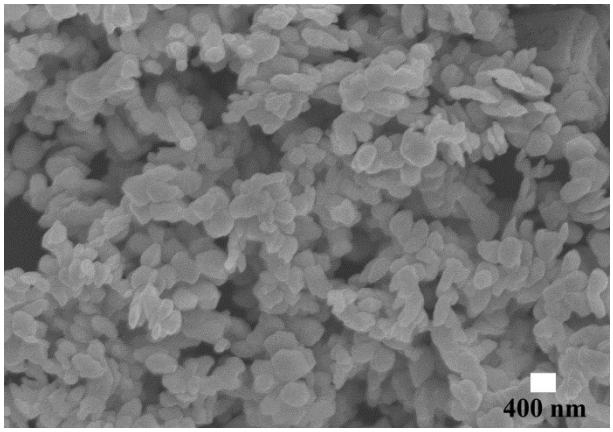

Fig. S7 SEM image of $NaYF_4$:Yb^{3+}/Er^{3+} UCNPs.

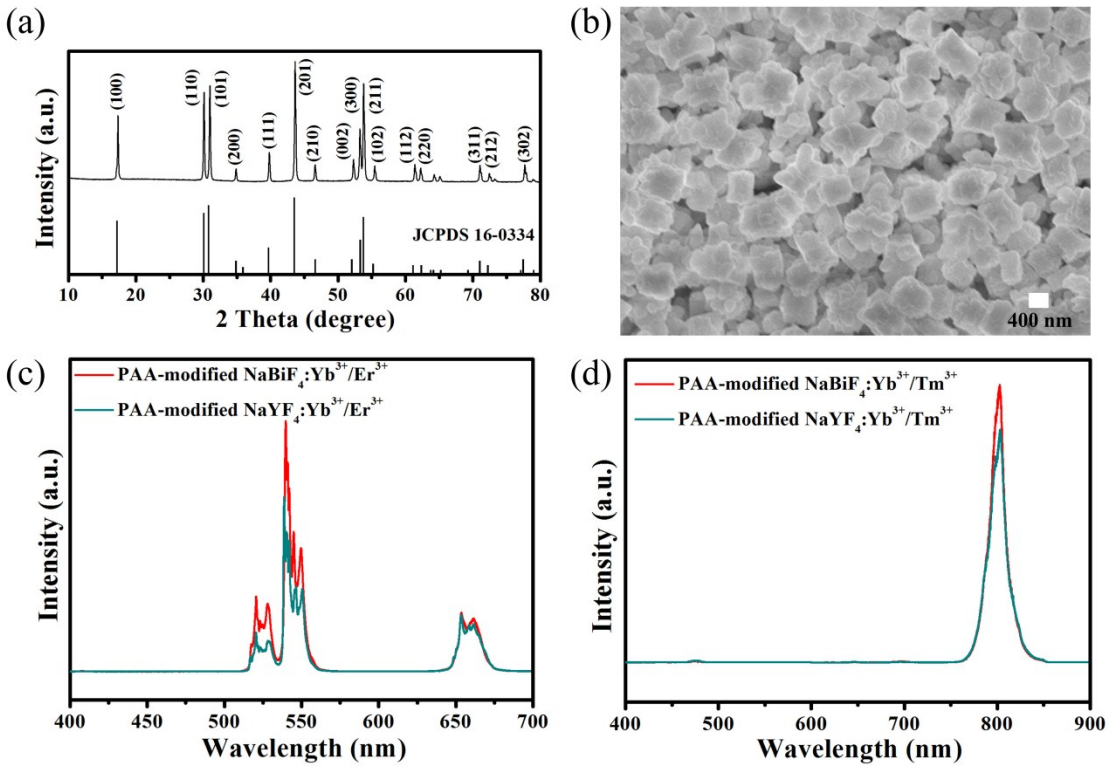

Fig. S8 XRD pattern (a) and SEM image (b) of PAA-modified $NaYF_4:Yb^{3+}/Er^{3+}$ UCNPs. UCL spectra of (c) PAA-modified $NaBiF_4:Yb^{3+}/Er^{3+}$ and PAA-modified $NaYF_4:Yb^{3+}/Er^{3+}$ and (d) PAA-modified $NaBiF_4:Yb^{3+}/Tm^{3+}$ and PAA-modified $NaYF_4:Yb^{3+}/Tm^{3}$ under 980 nm NIR excitation (11.3 W/cm^2).

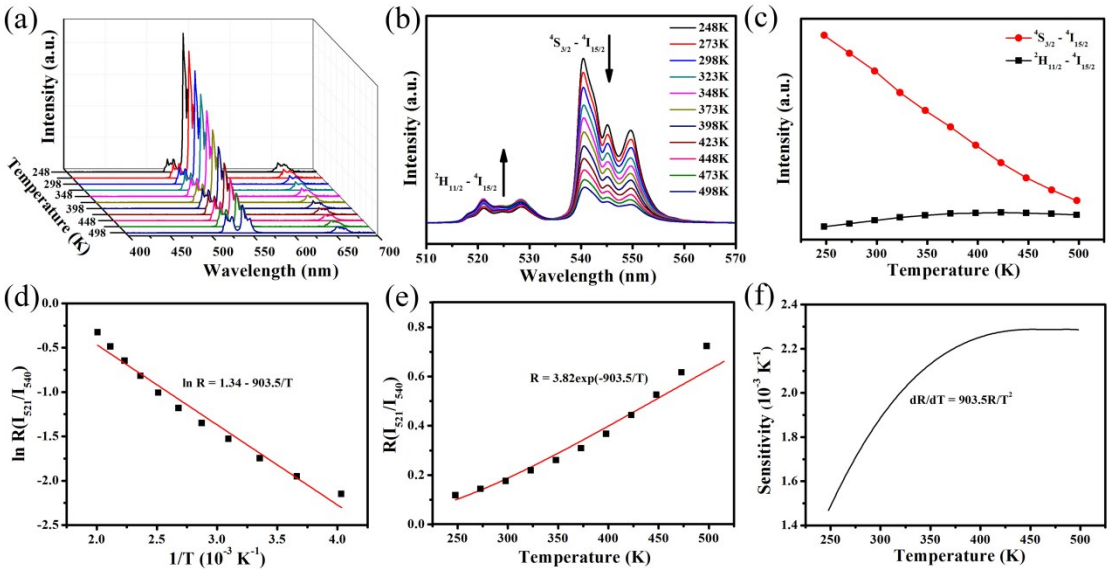

Fig. S9 (a) Temperature dependent UCL spectra of $NaBiF_4$:Yb^{3+}/Er^{3+} UCNPs at various temperatures under 980 nm excitation (21.2 W/cm^2). (b) The green UCL spectra of Er^{3+} from $^2H_{11/2}$ and $^4S_{3/2}$ levels to the $^4I_{15/2}$ level at different temperature. (c) The integrated luminescence intensity plots of Er^{3+} at 521 ($^2H_{11/2}$ - $^4I_{15/2}$) and 540 nm ($^4S_{3/2}$ - $^4I_{15/2}$). (d) Monolog plot of R (I_{521}/I_{540}) as a function of inverse absolute temperature. (e) R (I_{521}/I_{540}) relative to the absolute temperature. (f) The sensing sensitivity as a function of the absolute temperature.